Predicting shorebird habitat on the Arctic Coastal Plain of Alaska

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Arctic Coastal Plain of Alaska

- Provides important habitat for millions of nesting and migrating shorebirds
  - At least 29 breeding shorebird species
  - Six million estimated to breed in the National Petroleum Reserve of Alaska alone
- Population declines documented for 11 species
  - Of which, 9 are considered species of high conservation concern or are highly imperiled on a global scale (U.S. Shorebird Conservation Plan 2004)
- As much of the Coastal Plain remains undeveloped, threats to nesting and migrating shorebirds within this region have been limited

Threats to the Coastal Plain

- Climate change
  - Warming rates are almost twice the global average
  - Current projections predict a 1.6°C increase in temperatures and 12% increase in precipitation by mid-century
    - Impact physical and ecological variables that could dramatically alter shorebird habitats
- Development
  - New and expanding native villages, as well as mineral, oil, and natural gas production
    - Direct loss of shorebird habitat and indirect effects on physical and ecological variables

Evaluation of Threats

- Document current shorebird distributions and determine habitat selection patterns of shorebirds within this region
  - These are poorly known or only coarsely defined for the Coastal Plain
- Determining these will provide baseline estimates to assess the potential impacts of specific development and climate change scenarios

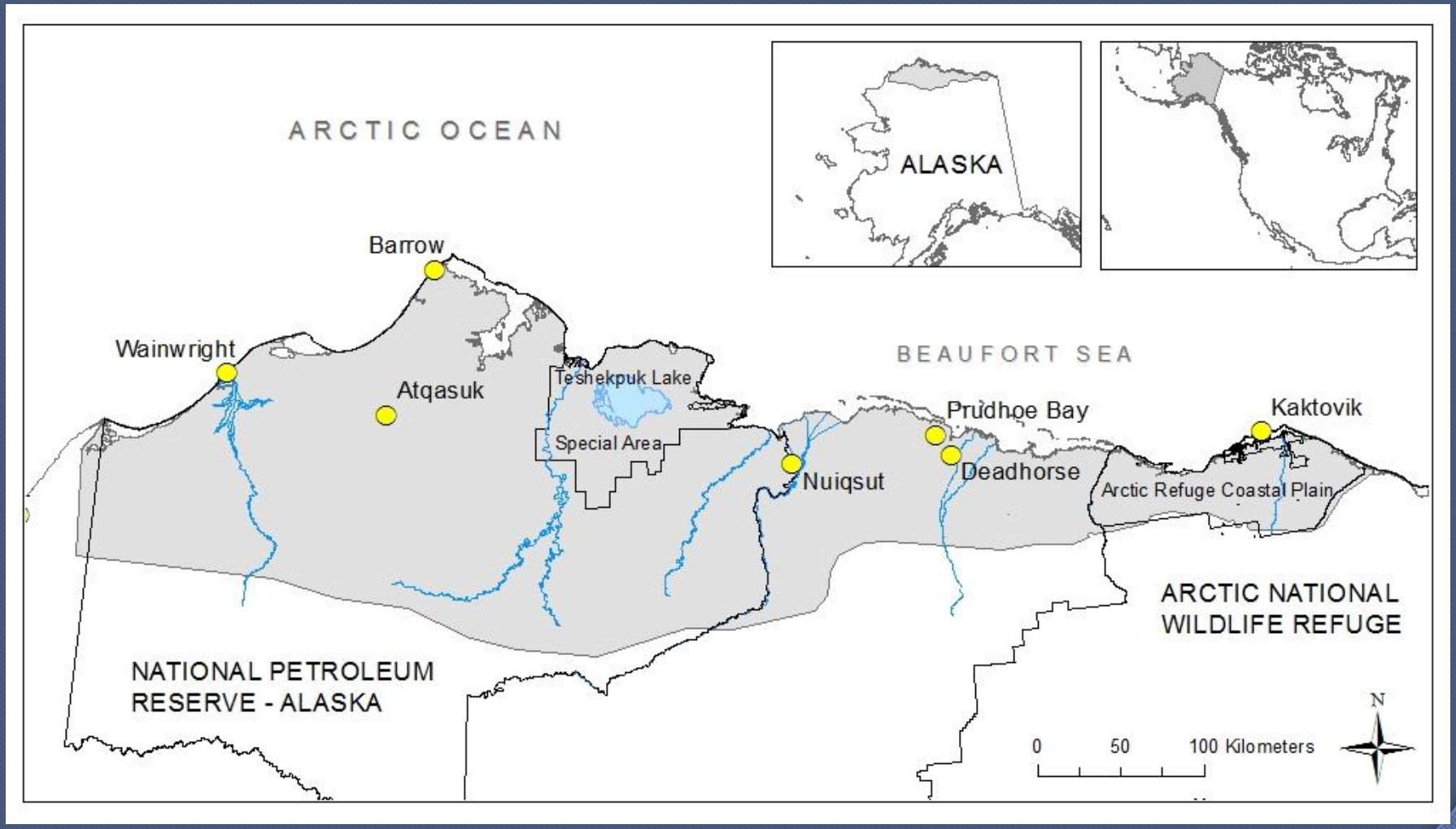
Objectives

- Document associations between the presence of shorebird species and large-scale physical and ecological variables

- Create predictive surfaces of shorebird species distributions on the Coastal Plain

Study Area

- Coastal Plain of Alaska: > 8.5 million ha area



Methods

- As part of the Program for Regional and International Shorebird Monitoring (PRISM), randomly and non-randomly selected plots were surveyed during 9 years between 1998 and 2008
- Between 7 June and 1 July, shorebirds were surveyed using a single-visit, rapid area search technique

Analysis

- Presence-only modeling techniques were used to create habitat suitability indices (HSI) for eight shorebird species present in > 25% of plots
- Plots for this analysis were restricted based upon
  - Size: < 1 km^2
  - Elevation: 0 – 350 m
  - Spatial redundancy: > 3 km distance between plots
- Prior to analysis, 20% of plots were withheld for accuracy assessment (validation plots)

Analysis

- We used partitioned Mahalanobis distance (D^2_k) models to estimate and map habitat suitability on remaining 80% of plots (calibration plots)

- Developed 28 *a priori* models with combinations of abiotic and biotic variables:
  - Elevation
  - Density of water bodies
  - Distance to coast
  - June temperature
  - % water
  - % riverine
  - % wet meadow
  - % moist meadow
  - % upland tussock tundra
  - % upland shrubby tussock tundra
  - % upland scrub

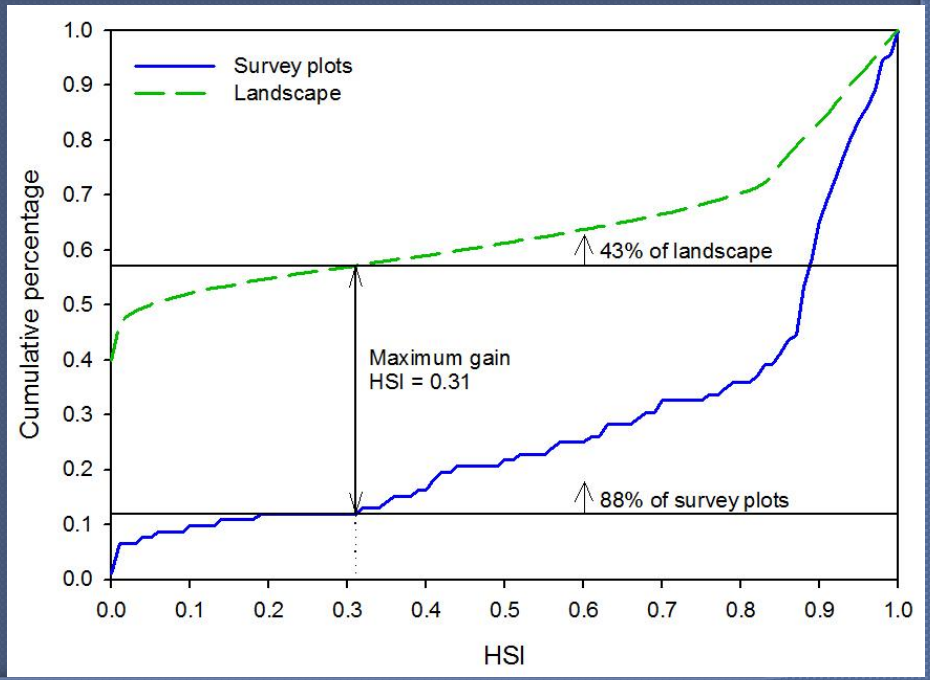


Analysis

- We assessed model performance at each *k*-partition and retained the best performing model as indicated by the predicted median HSI value for calibration plots
  - Best performing model: highest median HSI value for calibration plots

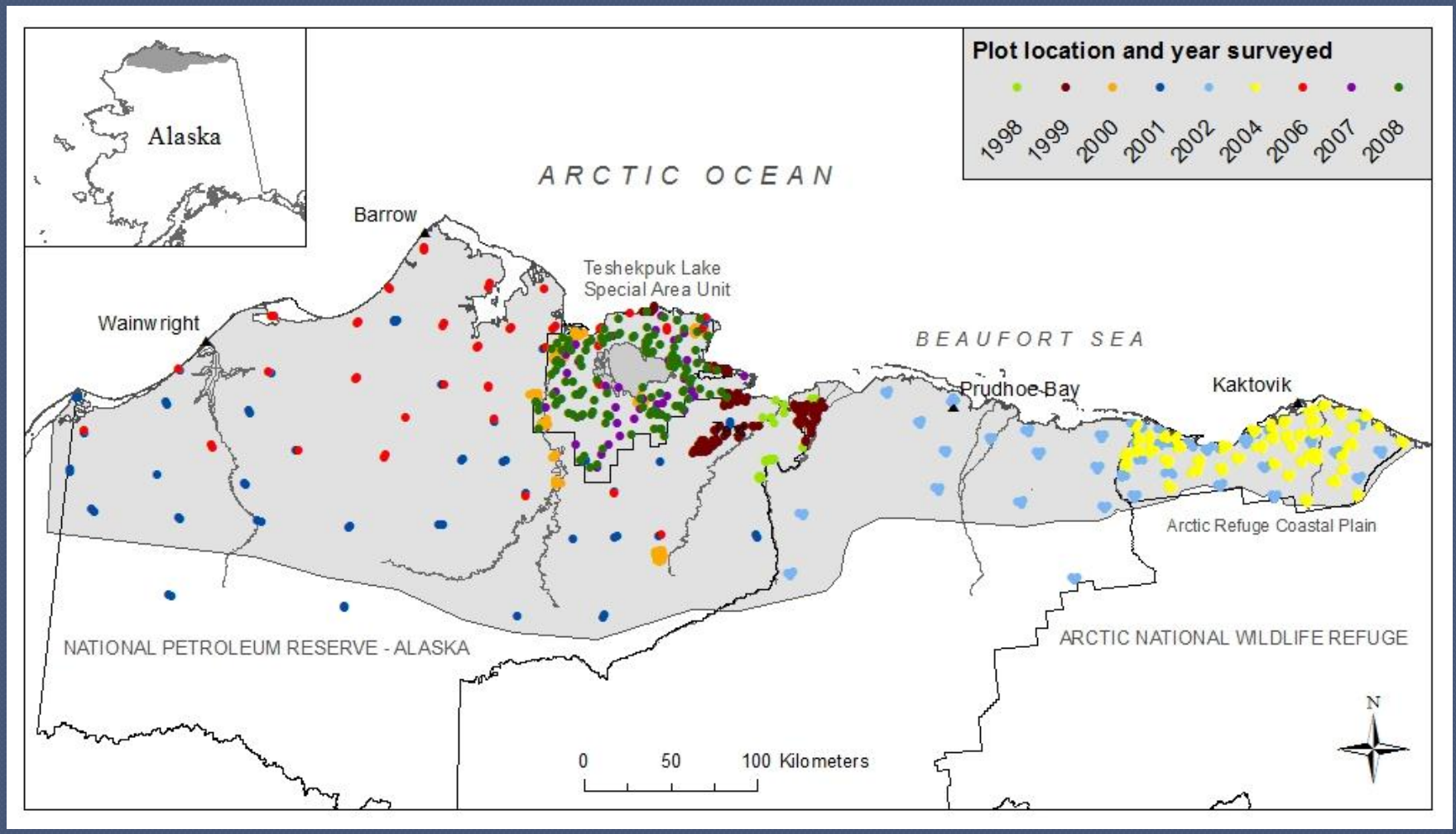
Analysis

- Uncertainty in model selection procedure was assessed using 1,000 bootstrapped samples
  - Proportion of times each candidate model returned the highest predicted median HSI when fit to a bootstrap sample
- Accuracy of predictive models was assessed using withheld plots
  - Predicted median HSI value
  - Proportion of plots accurately classified
    - Converted probabilities to presence/absence by maximizing predictive gain



Results

- Between 1998 – 2008, 767 plots were surveyed



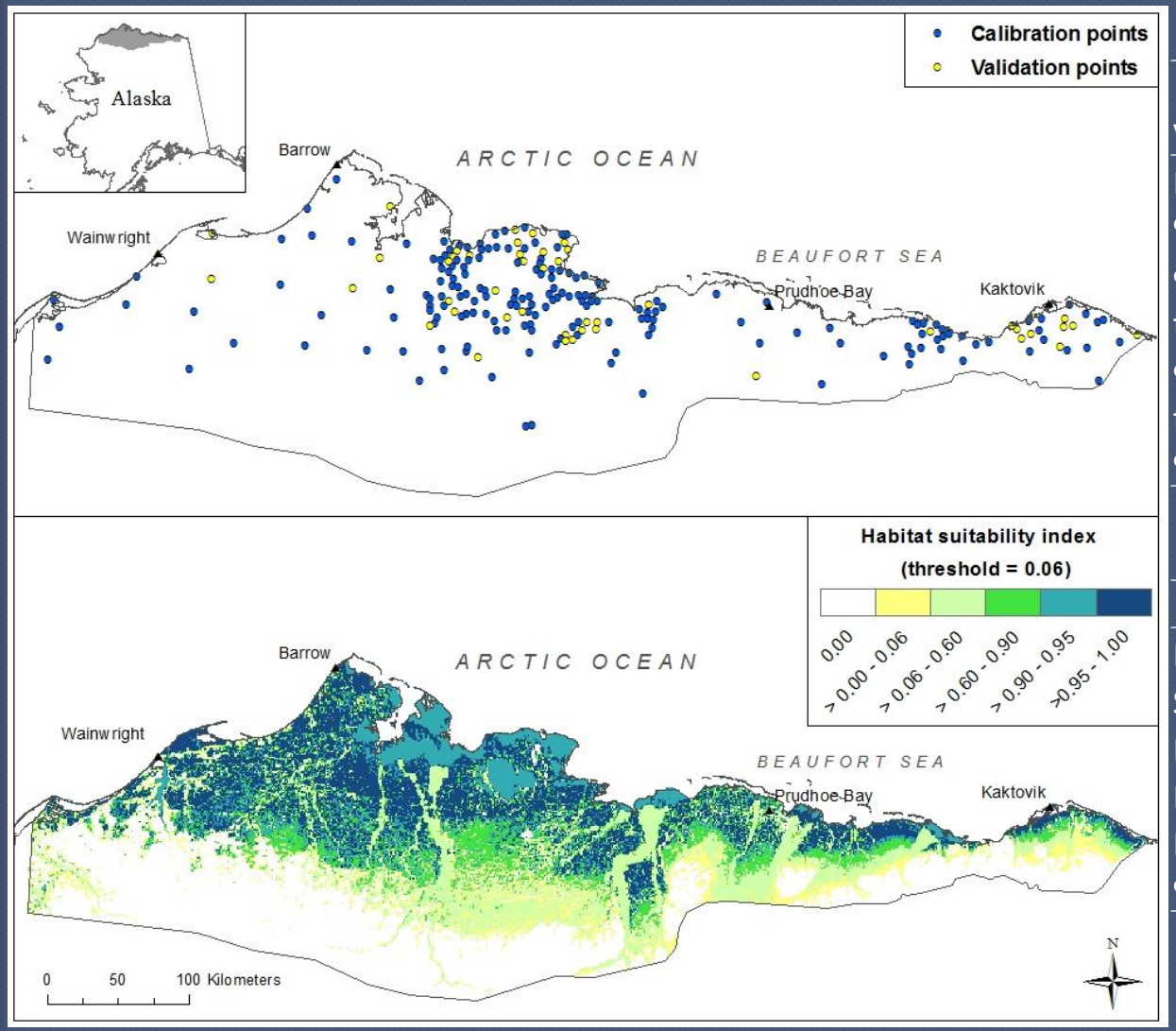
Results

- Within these plots, 12,358 shorebirds were detected, representing 21 shorebird species

- Eight species (11,655 individuals) were present in > 25% of plots

Species		Code	% of plots present
Black-bellied Plover	*Pluvialis squatarola*	BBPL	28%
American Golden-Plover	*Pluvialis dominica*	AMGP	27%
Semipalmated Sandpiper	*Calidris pusilla*	SESA	63%
Pectoral Sandpiper	*Calidris melanotos*	PESA	65%
Dunlin	*Calidris alpina*	DUNL	40%
Long-billed Dowitcher	*Limnodromus scolopaceus*	LBDO	44%
Red-necked Phalarope	*Phalaropus lobatus*	RNPH	47%
Red Phalarope	*Phalaropus fulicaria*	REPH	43%

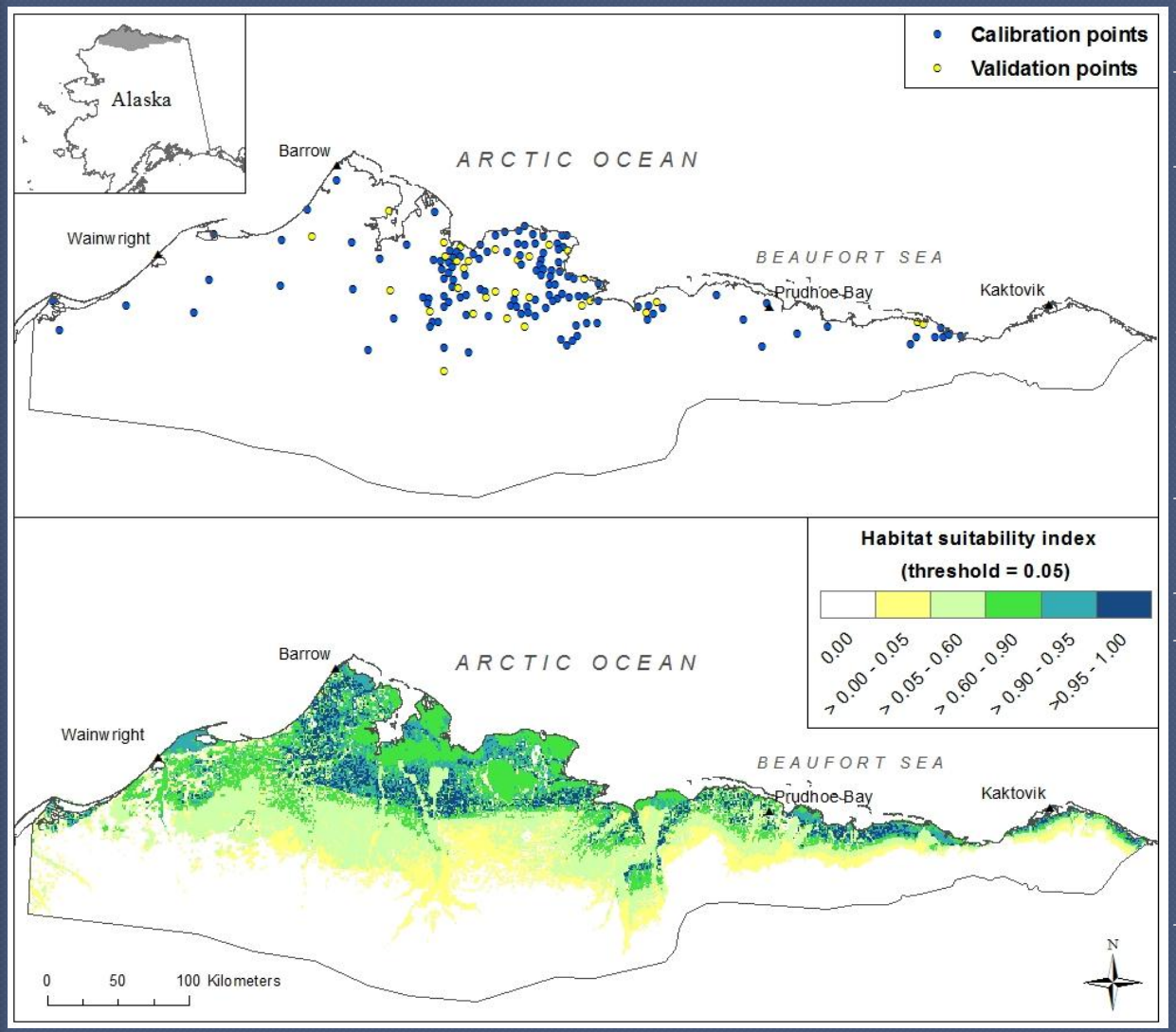
Semipalmated Sandpiper HSI



Variable	Landscape mean	Plot mean
Elevation	60.29	21.95
% riverine	0.08	0.14
% upland tussock tundra	0.18	0.05
% upland shrubby tussock tundra	0.09	0.00
% upland scrub	0.08	0.03

Model results	
Number of partitions	5
Selected partition (*k*)	1
Median calibration HSI	0.94
Median validation HSI	0.94
Bootstrap selection frequencies	0.51
% accurately classified	0.98

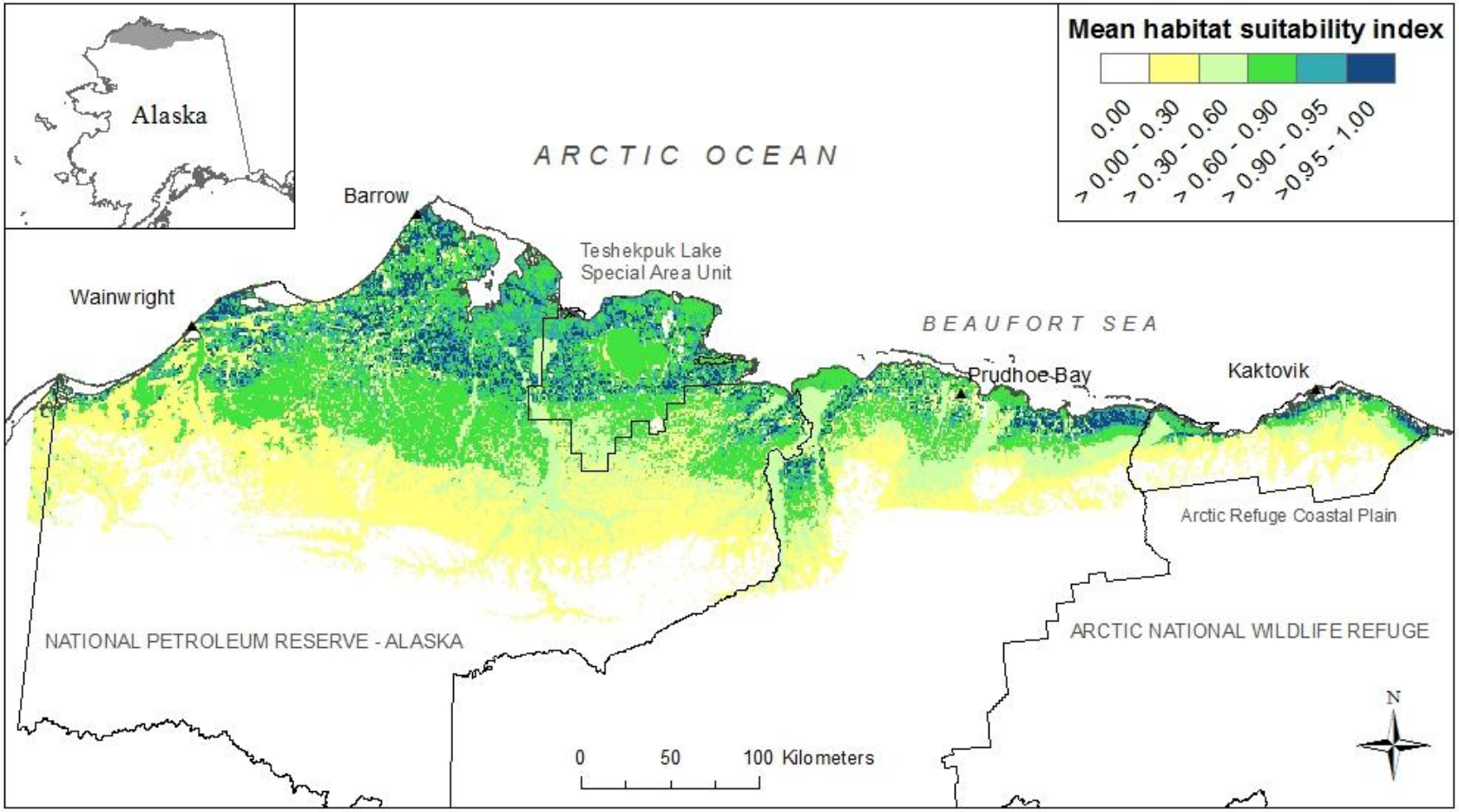
Dunlin HSI



Variable	Landscape mean	Plot mean
Elevation	60.29	10.71
% riverine	0.08	0.11
% upland tussock tundra	0.18	0.03
% upland shrubby tussock tundra	0.09	0.00
% upland scrub	0.08	0.02

Model results	
Number of partitions	5
Selected partition (*k*)	1
Median calibration HSI	0.86
Median validation HSI	0.89
Bootstrap selection frequencies	0.35
% accurately classified	0.87

Species Richness



Conclusions

- Baseline maps showing shorebird distributions within the Coastal Plain are now available for the first time
  - Most species had high accuracy
- Most species selected areas with lower elevations and less upland habitat than available on the landscape
- Important conservation areas were identified by areas where suitable habitat for multiple species occurred
  - Northern portion of the NPR-A and TLSA, as well as coastal areas of the ANWR, west to Prudhoe Bay.

Future Considerations

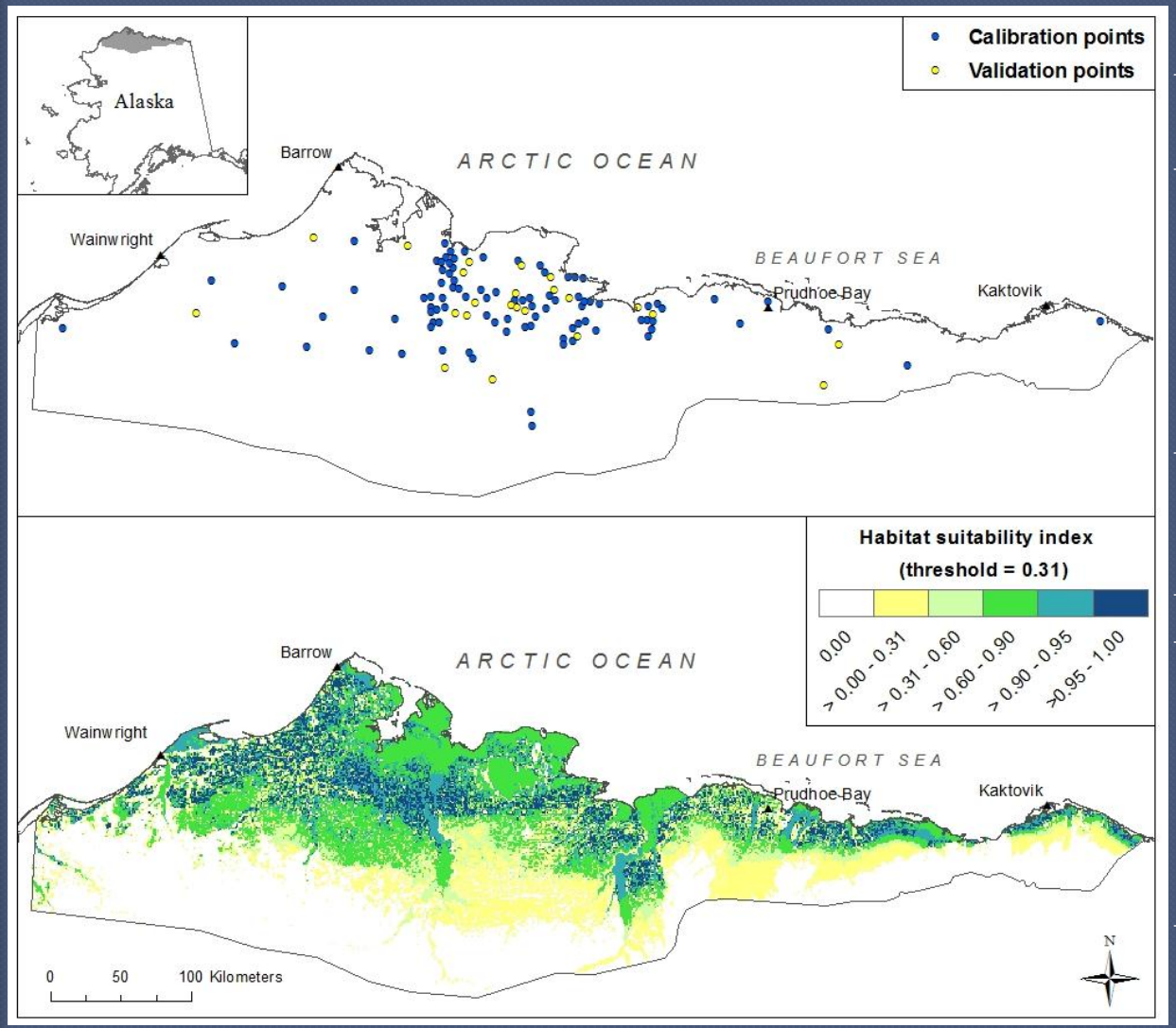
- Create predictive models for species density and species richness
- Incorporate habitat selection patterns and current distribution maps into future climate change and development scenarios
- Expand the use of this technique to other locations throughout Alaska

Acknowledgments

- We thank all the surveyors for their countless hours of field work that made this study possible
- This research was supported by the Arctic Landscape Conservation Cooperative, U.S. Fish and Wildlife Service, and Manomet Center for Conservation Sciences

Questions

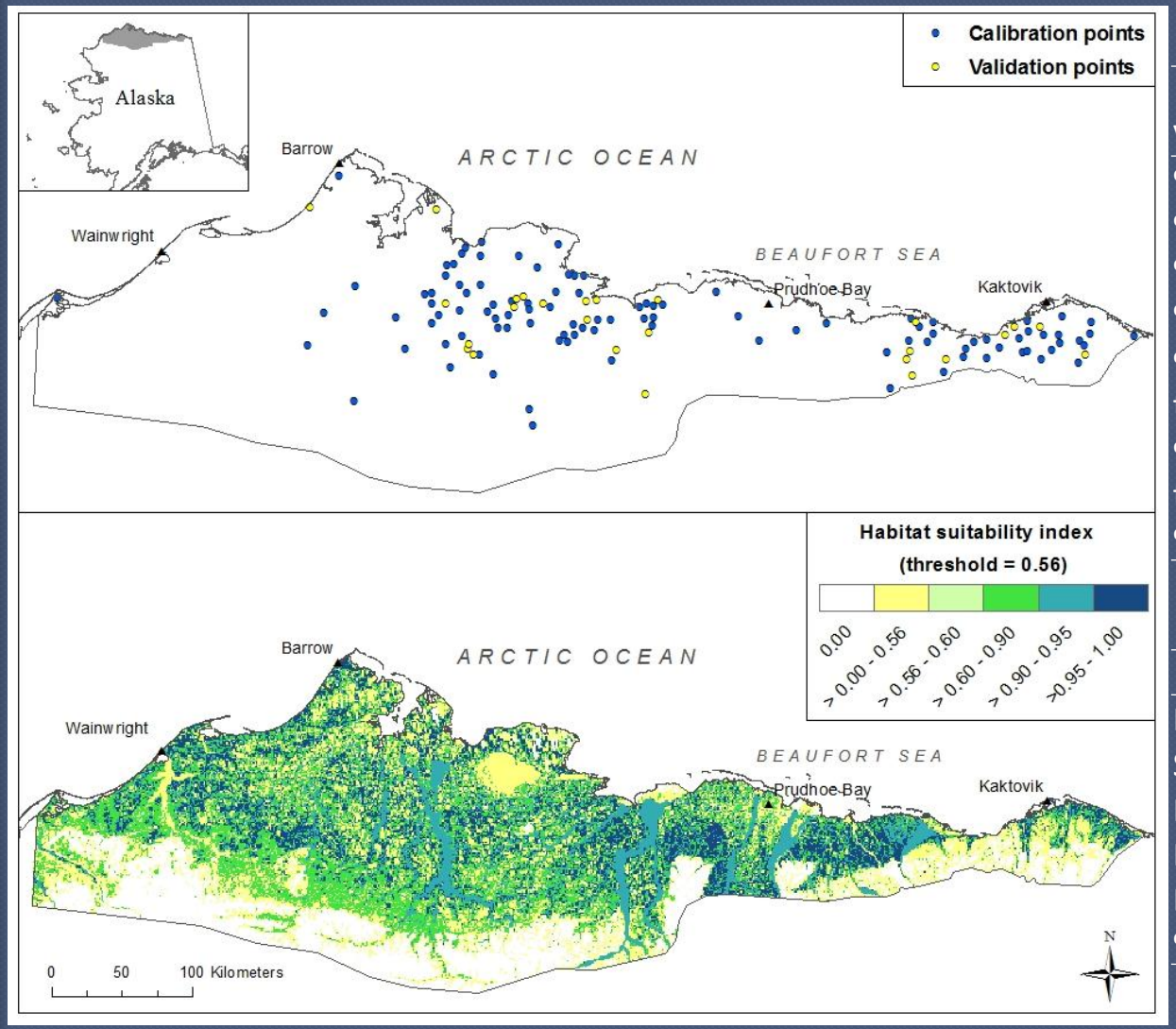
BBPL HSI



Variable	Landscape mean	Plot mean
Elevation	60.29	17.73
% upland tussock tundra	0.18	0.04
% upland shrubby tussock tundra	0.09	0.00
% upland scrub	0.08	0.02

Model results	
Number of partitions	4
Selected partition (*k*)	1
Median calibration HSI	0.87
Median validation HSI	0.87
Bootstrap selection frequencies	0.57
% accurately classified	0.74

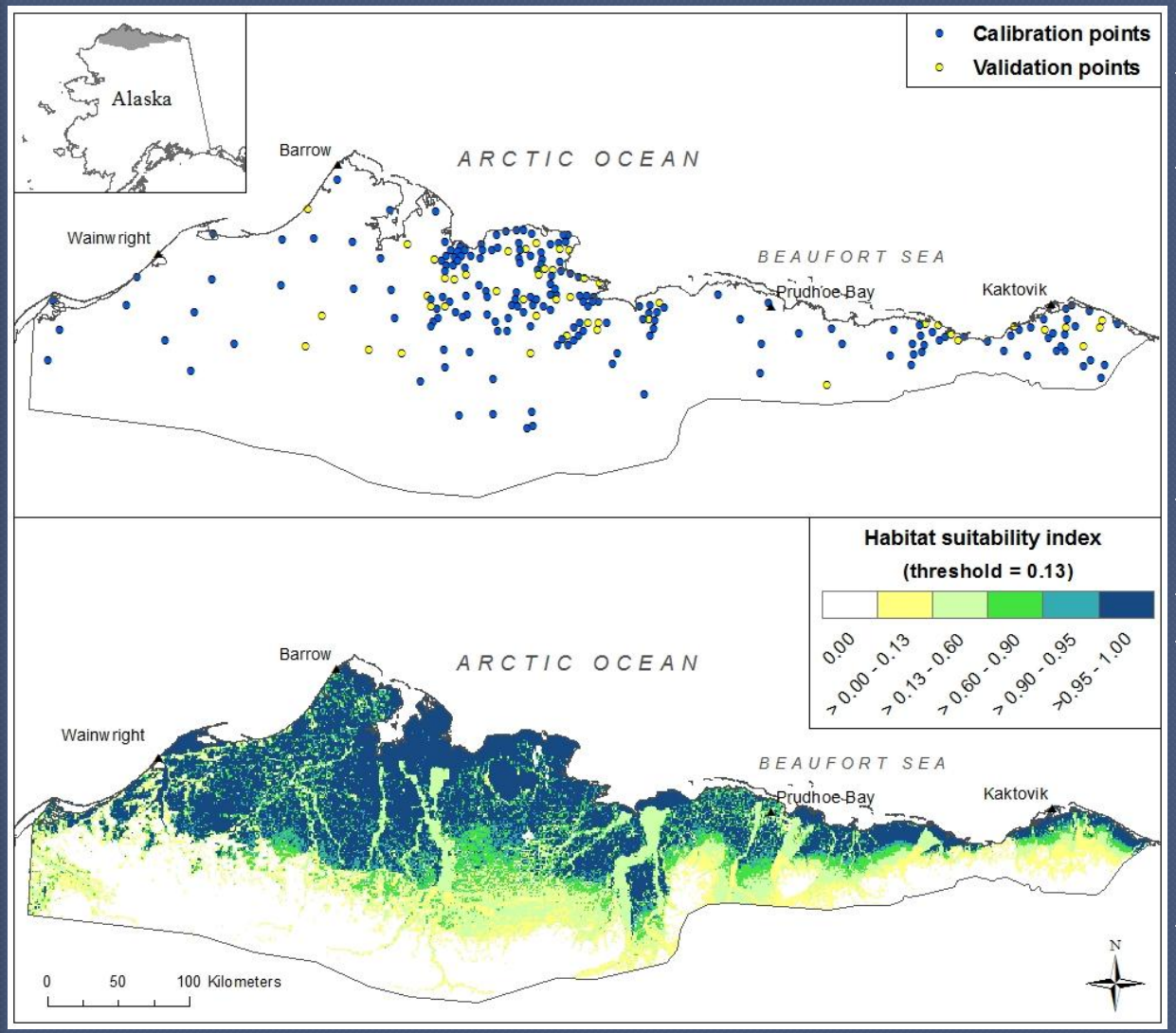
AMGP HSI



Variable	Landscape mean	Plot mean
% river	0.08	0.23
% water	0.13	0.10
% wet meadow	0.17	0.29
% moist meadow	0.23	0.24
% upland tussock tundra	0.18	0.05
% upland shrubby tussock tundra	0.09	0.02
% upland scrub	0.08	0.02

Model results	
Number of partitions	7
Selected partition (*k*)	6
Median calibration HSI	0.93
Median validation HSI	0.81
Bootstrap selection frequencies	0.18
% accurately classified	0.65

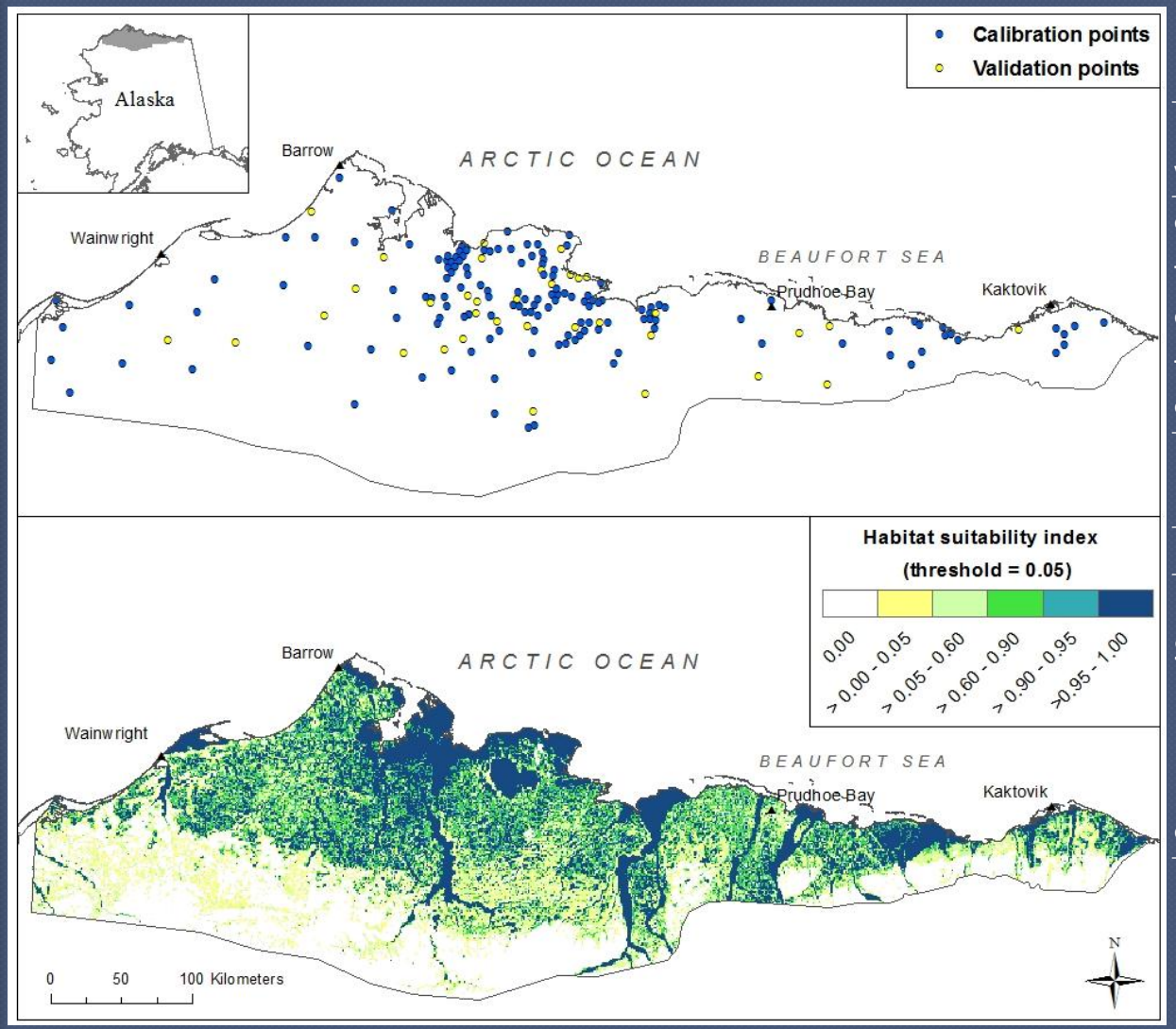
PESA HSI



Variable	Landscape mean	Plot mean
Elevation	60.29	25.45
% riverine	0.08	0.12
% upland tussock tundra	0.18	0.06
% upland shrubby tussock tundra	0.09	0.01
% upland scrub	0.08	0.03

Model results	
Number of partitions	5
Selected partition (*k*)	1
Median calibration HSI	0.97
Median validation HSI	0.97
Bootstrap selection frequencies	0.57
% accurately classified	0.96

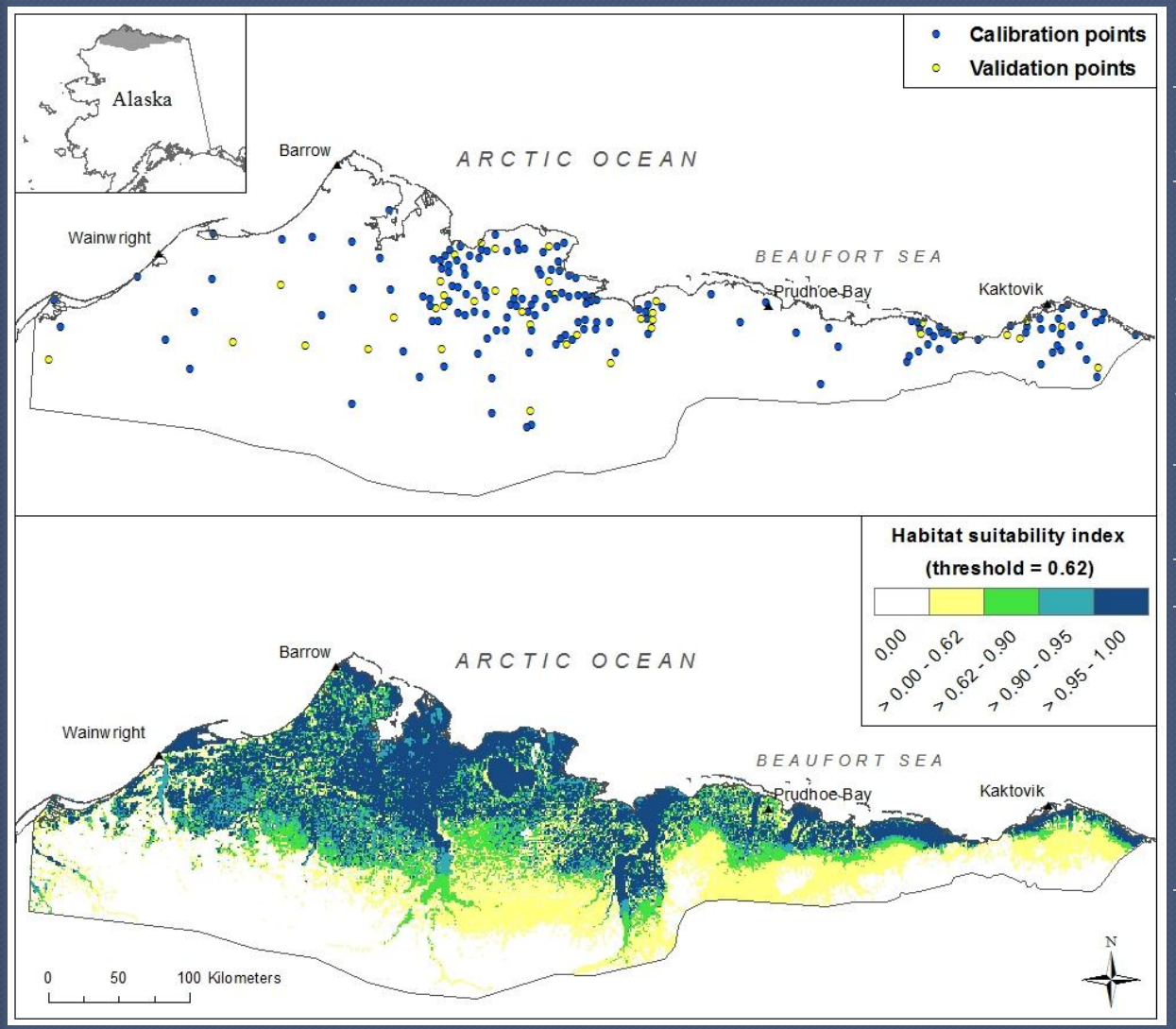
LBDO HSI



Variable	Landscape mean	Plot mean
% upland tussock tundra	0.18	0.06
% upland shrubby tussock tundra	0.09	0.00
% upland scrub	0.08	0.03

Model results	
Number of partitions	3
Selected partition (*k*)	2
Median calibration HSI	0.95
Median validation HSI	0.92
Bootstrap selection frequencies	0.28
% accurately classified	0.91

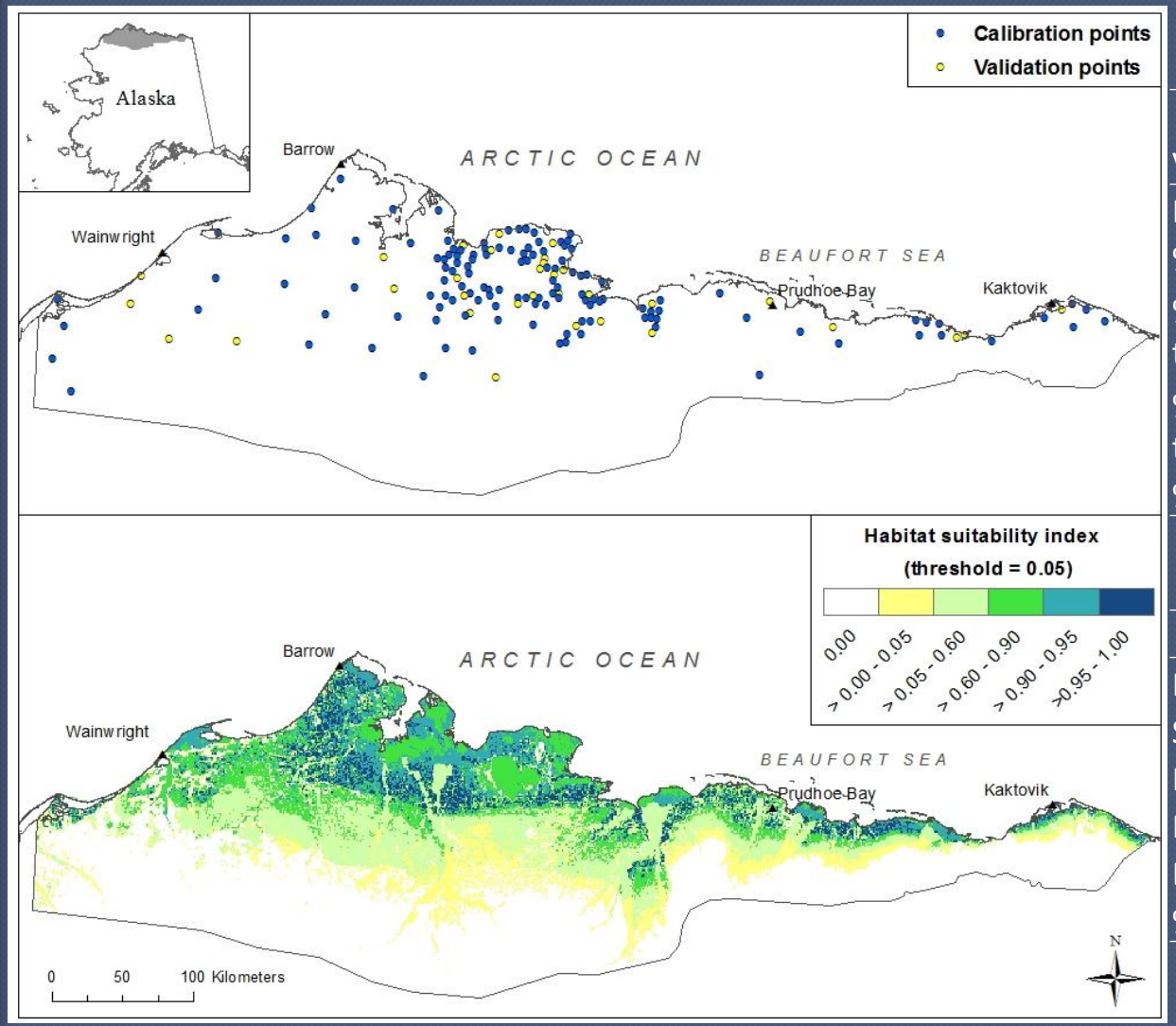
RNPH HSI



Variable	Landscape mean	Plot mean
Elevation	60.29	25.28
% upland tussock tundra	0.18	0.05
% upland shrubby tussock tundra	0.09	0.01
% upland scrub	0.08	0.03

Model results	
Number of partitions	4
Selected partition (*k*)	1
Median calibration HSI	0.96
Median validation HSI	0.96
Bootstrap selection frequencies	0.51
% accurately classified	0.85

REPH HSI



Variable	Landscape mean	Plot mean
Elevation	60.29	12.00
% riverine	0.08	0.12
% upland tussock tundra	0.18	0.03
% upland shrubby tussock tundra	0.09	0.00
% upland scrub	0.08	0.02

Model results	
Number of partitions	5
Selected partition (*k*)	1
Median calibration HSI	0.88
Median validation HSI	0.87
Bootstrap selection frequencies	0.34
% accurately classified	0.88